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ABSTRACT

A system and method for real-time monitoring and tracking of multiple transmitter unit(s) devices that are attached to people or objects of interest is described. The system consists of 1 base station and multiple transmitter unit(s) units. The transmitter unit(s) units are small, lightweight, simple devices that can be attached to any object that requires monitoring and tracking. The combination of the base unit and the transmitter unit(s)s measures distance, direction, altitude (tracking on the Y axis) and mobile state (moving or stationary) of the objects. Utilization of audio cues and a graphical user interface for displaying information on the subject being tracked is an integral part of this method and system. Unique coding of signals allows singular objects to be individually monitored and tracked.

The transmitter sends a continuous signal that contains a set of independent variables that express the coordinates of the transmitting device in relation to the receiver. The receiving unit is equipped with an alarm, which provides audible (including voice instructions), visible, and sensory notification when the transmitter has exceeded the predetermined distance from the receiver. The signal is bi-directional sent from either the transmitter to the receiver or receiver to transmitter.

FIELD OF THE INVENTION

This invention provides a method for tracking and monitoring the distance, direction, altitude, and specific location of a single or multiple transmitter(s) units utilizing a receiving unit. The base or receiving device utilizes a GUI as well as sensory and audio alarms, including voice commands providing information on each specific transmitter being tracked.

The use of systems and methods to monitor movements and locations utilizing a base receiving unit and transmitting unit to track pets, property, and individuals is currently available. Recently, an increase in awareness of child abductions, missing elderly and pets has increased the need for a practical solution. The critical point in recovery is immediate notification that a person, pet or object is missing and acting within the first few seconds.

Currently, Global Positioning Satellite (GPS) based tracking and monitoring devices are used. The commonly used systems or methods utilize technology that requires Internet access and has no

proactive alert features. This technology is not real-time and has a delayed response, as the signal requires transmission to a satellite. GPS requires line of sight to the sky, and will not work in most buildings, as well, coverage is limited to particular regions.

The present invention's technology provides capability of real-time accurate monitoring of distance, direction, altitude, and specific location of a single or multiple transmitter units. In addition, immediate notification of the tracked object or person moving out of the predetermined area is provided.

INVENTION SUMMARY

The present inventions technology provides a system and method for real-time tracking and monitoring utilizing a GUI as well as spoken instruction, audio and sensory alarms to track the following; distance, direction, altitude, and specific location of a single or multiple transmitters utilizing a base station and transmitting device(s). This system and method monitors people, pets, or personal property.

The system includes, at least two components, a transmitter and a receiver. The receiver monitors the transmitter unit. The base or receiving unit utilizes low frequency pulsating technology broadcast by the transmitting unit to track and receive information about the location of the transmitting unit. The receiving unit provides information about the location of the transmitter unit in relation to the location of the receiving unit.

Information is filtered and analyzed by the receiving unit and is displayed in GUI format, utilizing audible including spoken instruction, as well as sensory alarms.

This invention will address the problems with children being left unattended in vehicles as a result of caregivers forgetting them, and provide immediate information on the location of children who may be lost or who have disappeared.

BACKGROUND OF THE INVENTION

Recently, an increase in awareness of child abductions, missing elderly and pets has increased the need for a practical solution to monitoring and tracking their whereabouts. The critical point in recovery is immediate notification that a person or object is missing and acting within the first seconds' to find them. This invention is a system that allows one individual to keep track of several other pets, objects or individuals. The invention consists of two parts, a base station and a tracker. The tracker is referred to as a Mobie. Together the

ADVANTAGES OVER PRIOR ARTS

Currently, Global Positioning Satellite (GPS) based tracking and monitoring devices are used. The commonly used systems or methods utilize technology that requires Internet access as well provides no proactive features for immediate notification of a missing pet or object.

GPS technology is not real-time and has a delayed response, as the signal requires transmission to a satellite. GPS requires line of sight to the sky, and will not work in most buildings, as well, coverage is limited to particular regions.

GPS based technology products do not provide critical functions such as guard function and a find function. The guard function allows the base station user to set a distance that defines the guard region. If a transmitting unit is within the guard zone then nothing happens. If one or more of the transmitting units are outside of the guard zone then an alarm function is triggered and the base station can be used to find the transmitting unit that is outside the guard zone.

Current GPS technology does not allow for tracking independent of the internet does not work in environments such as indoor, rural areas, outdoors where line of sight to the sun is blocked. In addition, it relies on other infrastructure to be available or working to perform it's tasks.

The system and method described herein is unique in comparison to the systems and methods currently invented because of the following:

The current invention has the ability to track altitude or coordinates on the Y-axis, Integrates the ability to provide verbal direction and information in the way of locating the subject, Utilizes a Graphical User Interface for displaying information on the subject being tracked.

Utilizes unique encrypted PINS for secure monitoring, sends signals continuously sent utilizing pulse technology and unidirectional signals, whereas other inventions use bi-directional signals. The current invention has integrated memory component to enable tracking the last coordinates sent out by the transmitting unit.

The current invention has the ability to utilize intelligent mapping for reliably tracking transmitter devices, as well may integrate the use of various technologies including flash memory or cards to allow tracking using various devices as base stations.

DESCRIPTION OF THE PREFERRED EBODIMENT

The product consists of two parts, a base station and a tracking unit(s). The tracker is referred to as a Mobie. Together the devices provide two functions, a guard function and a find function. The guard function is performed by a communications scheme between the base station and the Mobie. Periodically the base station sends out a short unique coded message to an individual Mobie. Upon receiving the message the Mobie repeats back the message to the base station. The messages are sent with a BFSK signal at the Guard Zone frequency (see figure 7). Each Mobie and base station pair has a unique coded message that is established during a calibration phase. If the base station is keeping track of more than one MOBIE, then each MOBIE is queried in a round robin fashion. The base station allows a user to input the distance desired for the radius of the guard zone. This distance is used to calculate the power level that the base station transmits. The Mobie measures the power level of the received signal. If it is below a threshold the Mobie assumes that it has strayed out of the guard zone and begins broadcasting a Find Me signal. The Find Me signal uses a different frequency than the Guard Zone frequency.

The find function is implemented using the array processing method of Direction Finding (DF)(see figure 8). The array consists of 4 omni directional antennas arranged in a square grid that is attached to the bottom of the base station. The grid is normally held in a horizontal plane and the direction is found relative to that plane. The plane may also be held vertically in order to resolve direction in the vertical plane. When the Mobie is in the Find Me mode it broadcasts its unique code of FSK signals, but the signals have been shifted to the Find frequency. All Mobies and base stations use the same Find frequencies. In this way, any base station can be used to search for a Mobie that is in the FIND ME mode. If the Mobie is owned by the base station, then the directional display can show a vector pointing in the direction with an ID annotation. Other base stations would only show the direction.

The modulation and demodulation scheme that will be used for the coded message will be binary coherent FSK with a 10 kilohertz deviation about the carrier (20 kilohertz spread). The coded message is fixed for each Mobie and is downloadable from the base station. The coded message consists of 128 bits that is signaled at a baud rate of 10 kilohertz. This allows for an integer relationship between frequency deviation and baud rate. Each coded message will take 12. 5 milliseconds to transmit so that a base station supporting 8 Mobies will be able to query them once every 2 seconds. This allows a guard interval for each time slot to account for propagation delay between the Mobie and the base station. The coded messages are generated with a Walsh function so that the 128 bit sequences are orthogonal to each other. This will allow a matched filter to be used to separate different signals that may be arriving on the Mobie or the base station. In this way each base station Mobie pair will only interact with each other. This is a scheme similar to the CDMA used in cellular phones.

BASE STATION

The preferred embodiment of the base station is a digital cell phone, PDA, watch or other small device easy to carry. The user interface and displays are performed on the base station and the DSP performs the entire signal processing functions. The package has been carefully designed to make provisions for the antenna arrays and the download function docking port. The base station is designed with a processor and matching Analog Devices A/D and D/A. The processor is programmed to do the following functions:

- Create the modulating signal using a Walsh function generator. This produces a wave form that is unique for each Mobie.
- Create the modulated FSK waveform digitally and output through a D/A. This is fed into a linear amplifier and output to the antenna.
- Receive the FSK waveform response from the Mobie
- Demodulate the FSK waveform with a digital implementation of an FM discriminator
- Apply the appropriate matched filter to authenticate the received signal.
- Repeat the above steps for all active Mobies.
- Detect the presence of a Find Me signal at the find frequencies.
- If such a signal is present perform the Direction finding operation using the autocorrelation technique to measure the time difference of arrival between a pair of antennas.
- Repeat the direction finding operation on a second pair of antennas that are orthogonal to the first pair.
- Based on the two measurements resolve the direction of the Mobie unambiguously (figure 8)

The PDA receives inputs from the DSP to provide data for the display and outputs parameters to the DSP that are derived from the user interface. The user interface allows the following inputs:

- Power on a Mobie
- Power off a Mobie
- Set the guard distance

The base station shows the following information with various displays:

- The number of Mobies that are being monitored
- An arrow representing the direction of a Mobie outside the guard zone
- An annotation signifying whether the Mobie is a member of the base station set of Mobies

Mobie

The preferred embodiment of the Mobie utilizes technology to allow for the form factor to be as small as a dime. The DSP on the Mobie is programmed to perform some of the following functions:

- Listen for the coded waveform sent out by the base station
- If received demodulate and match filter the waveform
- If authenticated transmit a replica of the signal back to the base station and wait for the next query
- If not start transmitting the find me signal
- Allow the PIN bit stream to be downloadable and powered on or off

ALTERNATE METHODS OF THE INVENTION

It is envisioned that there will be several versions of the base station that will be tailored for different markets. These include a simplified version of the PDA that only has base station capabilities and a highly miniaturized version that may be worn as a wristwatch. There may also be versions of this technology that are used in cell phones and home burglar alarms.

The modulator used in both the base station and Mobie can also be constructed in several ways. The preferred embodiment builds all the signals digitally in the DSP and outputs then through a high speed D/A. The signal is then simply amplified with a linear amplifier and output to the antenna. In other version this may be done in more traditional ways using an analog modulator and filtering. This could be done with a circuit that contains a switching transmitter whose switch rate is driven by the bit stream or the more common VCO followed by a linear amplifier. Similar the FM discriminator is currently implemented in the DSP and this function also be done with a simple analog filter used as a slope detector.

The base station is also required to have a direction finding capability. There are several ways to do direction finding but most require that we measure the time delay or phase difference between two signals from two separate antennas. In the preferred embodiment we used a cross correlation method but there are several other ways to do that. The first is using a tapped delay line to equalize the time delay between the two signals. The second method uses a phase detector to measure the phase difference between the two signals.

Since the base station must have some intelligence it seems reasonable to use programmable processors to perform this function. However the Mobie has a much simpler functionality and a DSP might be replaced with more custom hardware. These include a mixed signal ASIC, two separate ASICS split along analog and digital lines or a FPGA for the digital portions and normal analog circuitry for the rest.

CLAIMS

1. A system and method for tracking and monitoring the distance, direction, and altitude of a single or multiple transmitter unit(s) in relation to a base station.
2. A wireless portable base unit for receiving signals from pre-programmed wireless portable transmitting unit(s).
3. A pre-programmed receiver that recognizes encrypted signals sent continuously from a transmitter.
4. Transmitter unit that emits encrypted signals, with PIN sequencing algorithms recognized by a pre-programmed receiving unit.
5. Receiving unit utilizes Graphical User Interface (GUI) as well as audio and sensory alarms to display information on the transmitting device(s).
6. The DSP algorithms in the receiver unit compensates for structural interferences for improved tracking.
7. The base station is programmable to adjust perimeter distance for tracking, change notification via audible, sensory and display alarms when the transmitter device exceeds the set perimeter.
8. If the transmitting device exceeds or surpasses the set radius, the base station will alarm displaying distance, direction and altitude of a single or multiple device(s).
9. The transmitter and receiving unit(s) are small enough (dime size) to be attached to clothing, shoes, jewelry or concealed on a pet collar
10. Each transmitter unit has an encoded programmable PIN, which is unique for every unit and continuously emits a "presence code" keeping the base station aware of its distance.

DRAWINGS

DESCRIPTION OF THE DRAWINGS

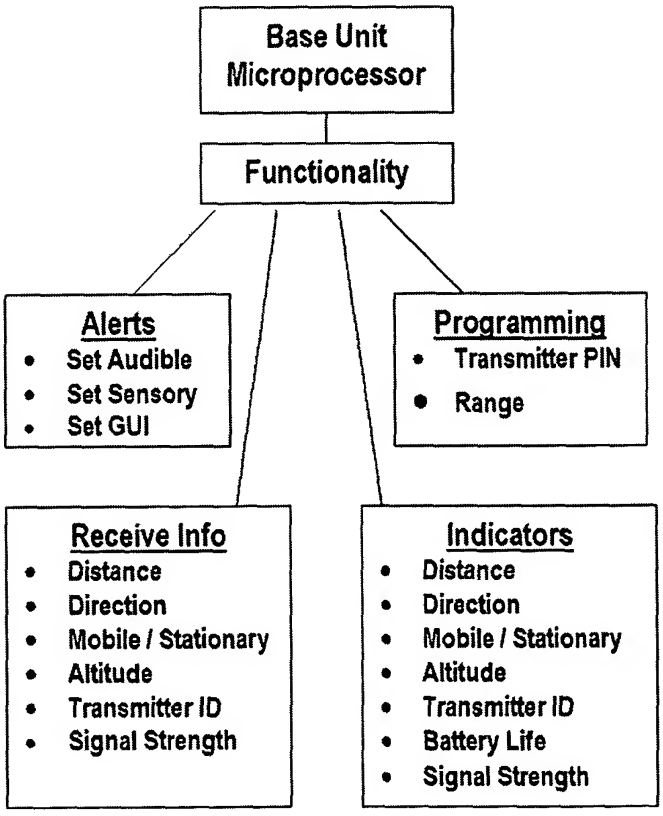


FIGURE 1
Block Diagram of the Receiver Unit.

The base unit utilizes a DSP and microprocessor to enable the following functions: Alerts, Programming, Receive info, and Indicators. Alerts include audible beeping and voice commands, sensory alerts (vibration alarm) and visual displays. Programming functions include downloading coded waveform to the transmitter unit(s). The base unit receives information from the transmitter unit(s) and derives transmitter unit(s) id, distance, direction, and altitude. The indicators reflect this information e received information sent via pulse signals as well as battery life.

FIGURE 2
Block Diagram of the Transmitter Unit.

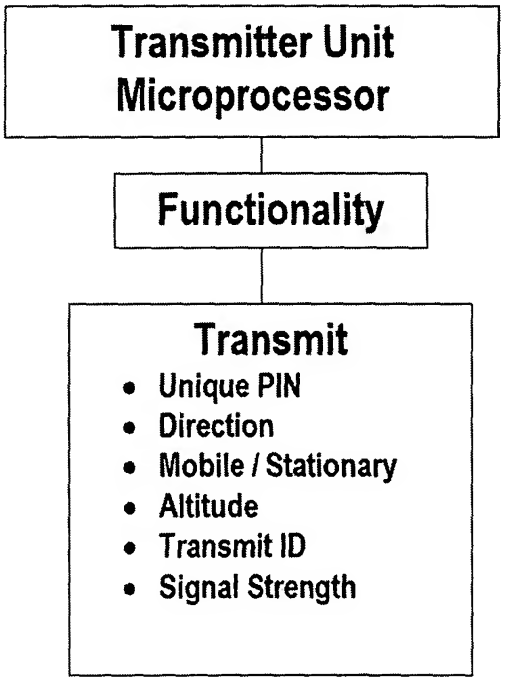


FIGURE 2
Block Diagram of the Transmitter Unit.
The transmitter units functionality includes receiving the base station query and responding to the query with its unique ID. In addition, the transmitter unit(s) can be powered on /off and programmed with its unique ID by the base station.

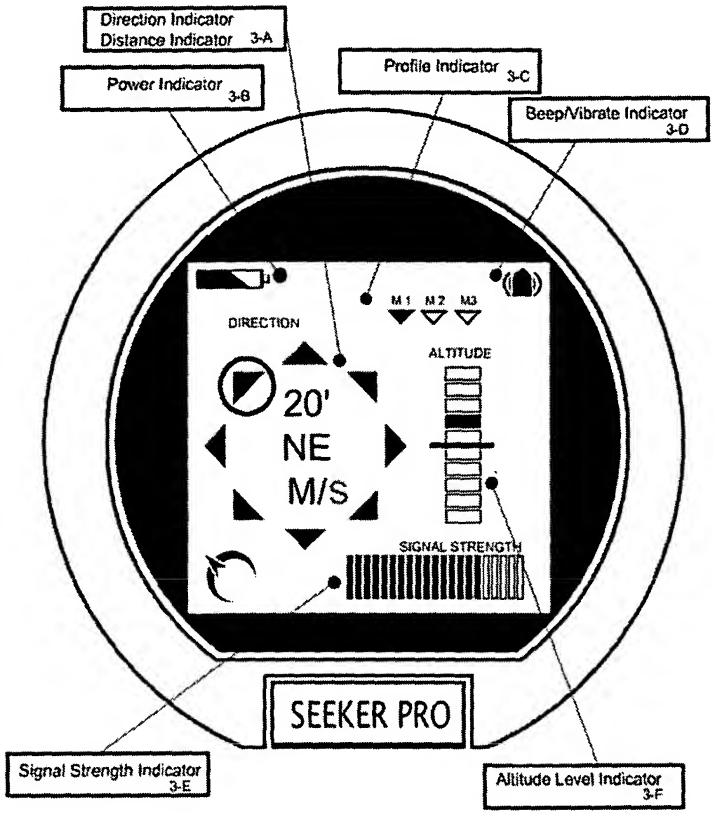


FIGURE 3
Direction and Distance Indicator
The direction and distance indicator is used to point in the direction of the subject that has a transmitter unit(s) attached to it and display an estimate of the distance.

The Direction on the indicator is displayed by placing a ring around the arrow that shows the position of the subject in relation to the position of the individual tracking the subject in real time. The distance of the subject is displayed in feet. The distance between the transmitter and the receiving device determines this. The distance is equally displayed in real time. The M is displayed if the subject is still changing direction on any of the x, y, z coordinates.
The S is displayed if the subject becomes immobile.

The Functions of this indicator are enabled by the (CPU) Central processing Unit in real time. The (CPU) Compensates for environmental reflections such as iron post with intelligent mapping memory. This allows for an accurate display of information at all times by the said indicator.

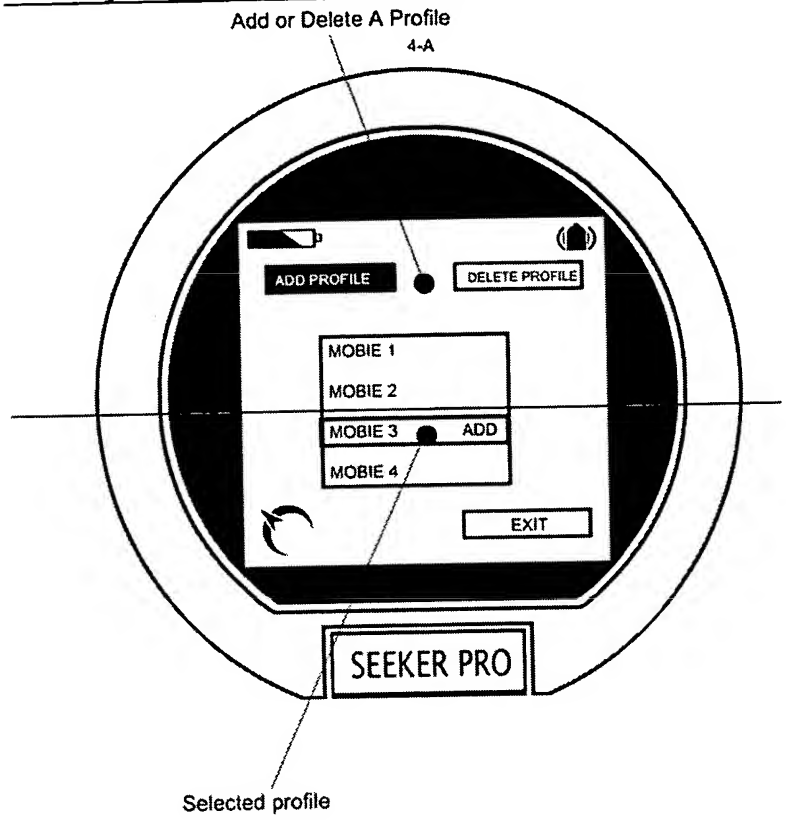
Power Indicator
The Power Indicator is used to determine the battery life of the lithium ion battery powering the device. Upon reaching a 7/8 depletion of the lithium ion battery the receiving device will start to give a warning beep every 30 seconds.

Profile Indicator
The Profile Indicator is used to determine which subject when and if tracking multiple subjects has exceeded the designated radius of the tracking and receiving device. The profile of the subject, which has left the predetermined radius, is displayed by a solid black triangle. The profiles are also labeled with a M1, M2, M3 or M4 etc.

Beep / Vibrate Indicator
The Beep / Vibrate Indicator is used to determine and display which or if both of the alarming settings are active. A bell is displayed for beeping alert. A set of quotation like or parentheses like brackets is displayed for vibrating alert.

Signal Strength Indicator
The Signal Strength Indicator is used to display the signal strength of the transmitting device in relation to the tracking and receiving device. The solid bars represent the strength of the signal being received from the transmitting device.

Altitude Indicator
The Altitude Indicator is used to display the Y coordinate of the subject being tracked in relation to that of the tracking and receiving unit. The line in the center of the Altitude level bar represents the position of the tracking and receiving device. When a subject being tracked leaves the predetermined radius and is above the tracking and receiving device the altitude indicator will display a solid bar above the line. When the subject(s) being tracked leaves the predetermined radius and is below the tracking and receiving device the altitude indicator will display a solid bar below the line.


Add or Delete A Profile
4-A
ADD PROFILE
DELETE PROFILE
MOBIE 1
MOBIE 2
MOBIE 3
ADD
MOBIE 4
EXIT
SEEKER PRO
Selected profile

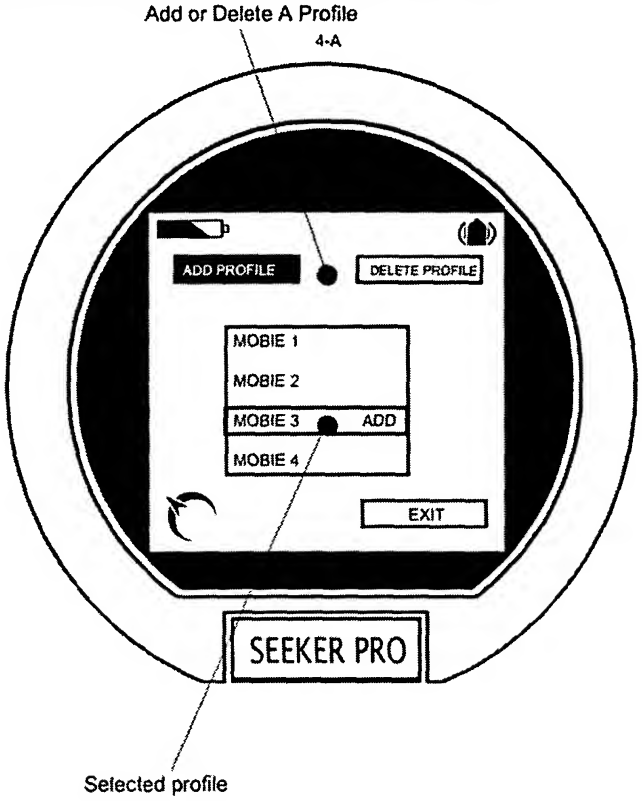


FIGURE 4
Add Profile
When adding a profile, the user places the transmitter next to the watch and presses the add profile button on the tracking and receiving device. Once the button has been pressed the tracking and receiving device proceeds to learn the Pin and tracking ID of the transmitter.
Once the ID and Pin have been learned the encryption prevents the pin and tracking ID from ever being used by anyone else to track the subject except the first tracking and receiving device that learned it.

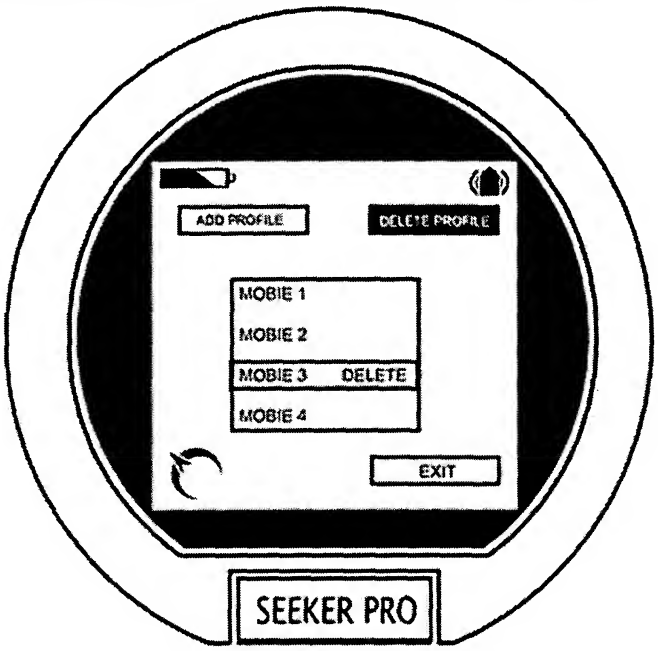
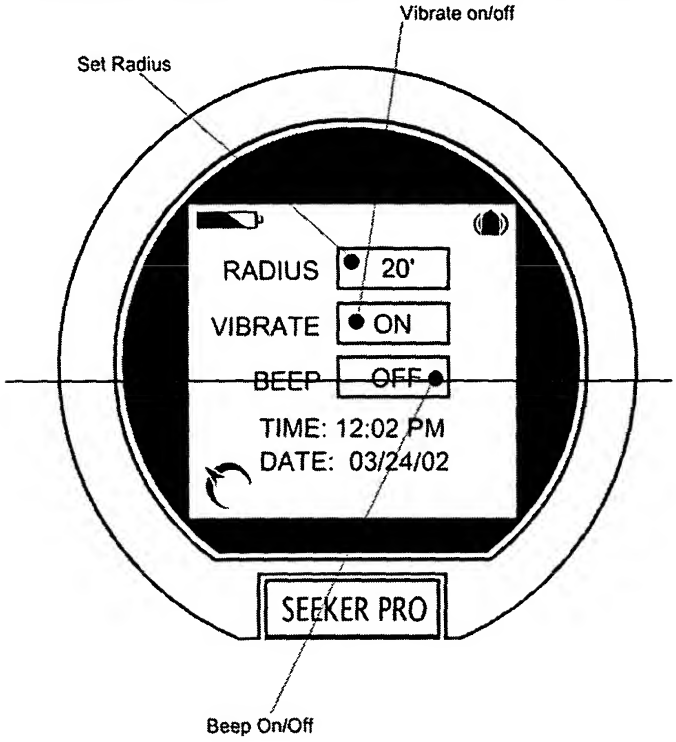


FIGURE 5
Delete Profile
When adding a profile, the user scrolls down to the profile in which they wish to discard of. The user will then proceed to press the delete Profile button on the tracking and receiving device. This will permanently delete the profile from the flash memory of the tracking and receiving device's flash memory.


Vibrate on/off
Set Radius
RADIUS
20'
VIBRATE
ON
BEEP
OFF
TIME: 12:02 PM
DATE: 03/24/02
SEEKER PRO
Beep On/Off

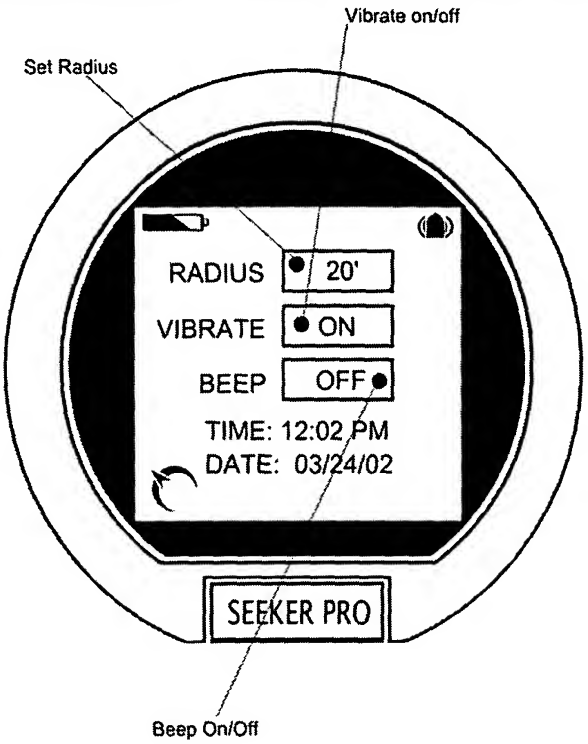


FIGURE 6
GUI Programming Screen

This GUI Screen allows the user to determine and input their desired variables for tracking subjects. The first field allows you to input the radius in the number of feet that will act as a parameter or safe zone. The Next field is the vibrate field which allows you to turn the vibrate function on or off. Following that field is the beep field, which allows you to turn the beep alert function on or off.

After those 3 Critical Function Fields you have the Time and Date Fields, which allow you to set the present time and date.

FIGURE 7

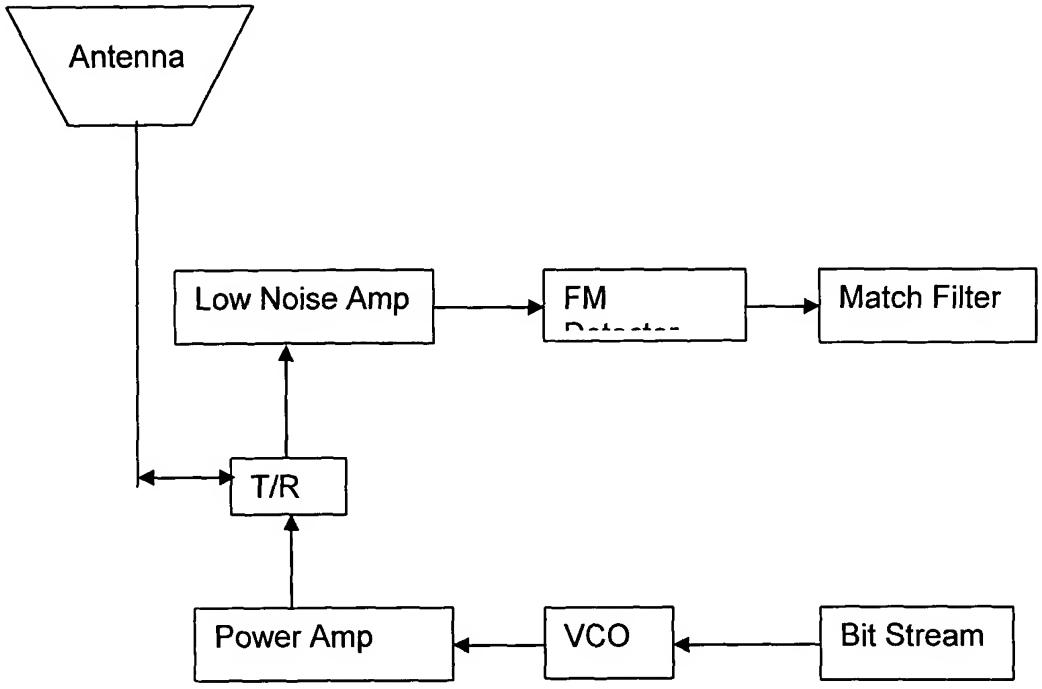


Fig.7

FIGURE 7
Block Diagram of the Guard Function Signal Processing.

This figure depicts the processing required to perform the guard function. This circuit is in both the Mobie and the base station.

FIGURE 8

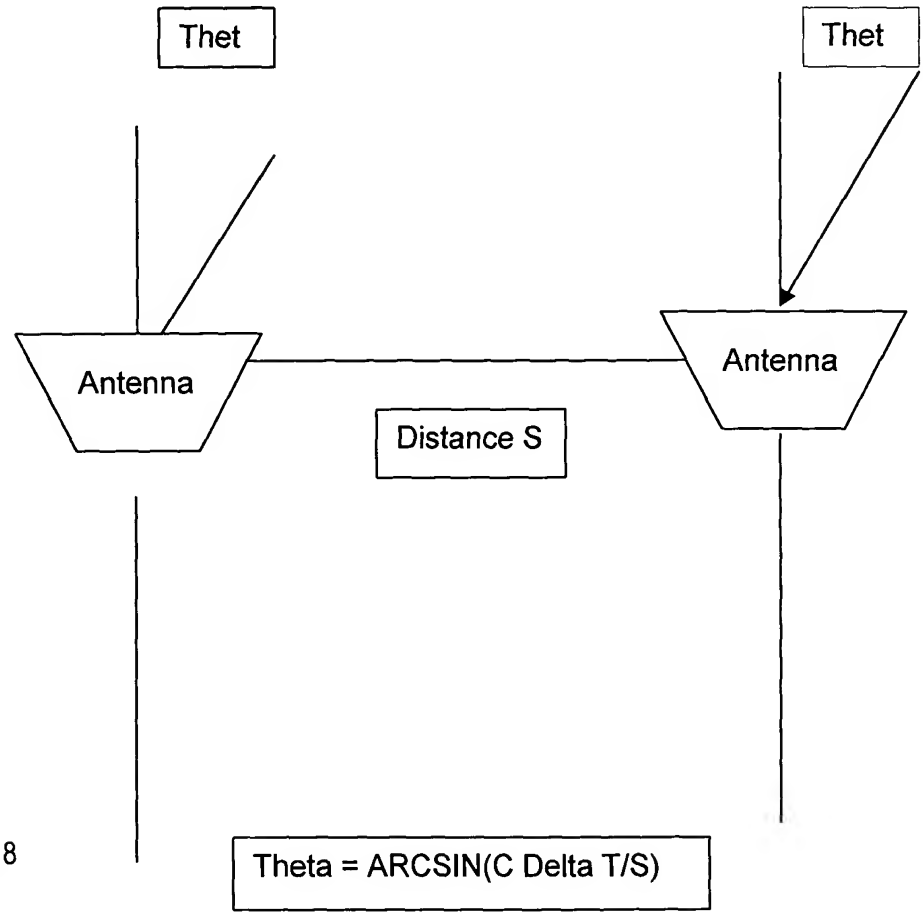


Fig. 8

FIGURE 8
Required Geometry for Direction Finding

This figure depicts the geometry required to perform direction finding. A transmitter at angle theta to the base line of the antennas produces a time delay in the reception of the signals between the antennas. If we measure the time delay we can calculate the angle of arrival.